

# Implementation of refraction in MYSTIC

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# Snell's law for a spherical atmosphere

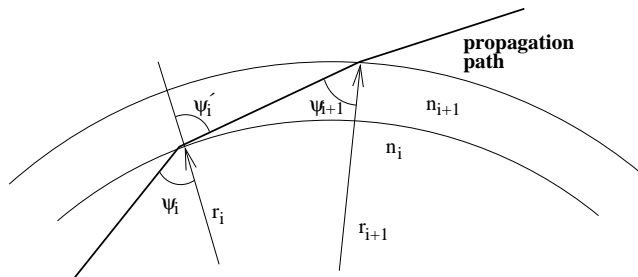


Figure: Geometry to derive Snell's law for a spherical atmosphere.

Snell's law of refraction:

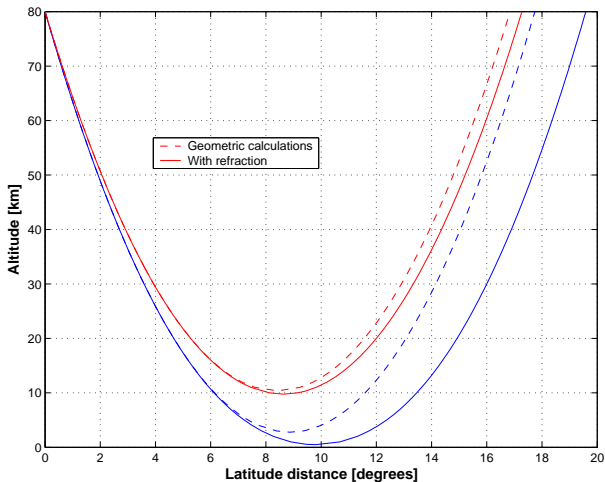
$$n_i \sin(\psi_i) = n_{i+1} \sin(\psi_{i'})$$

Snell's law for a spherical atmosphere (1D):

$$p_c = r_i n_i \sin(\psi_i) = r_{i+1} n_{i+1} \sin(\psi_{i+1})$$

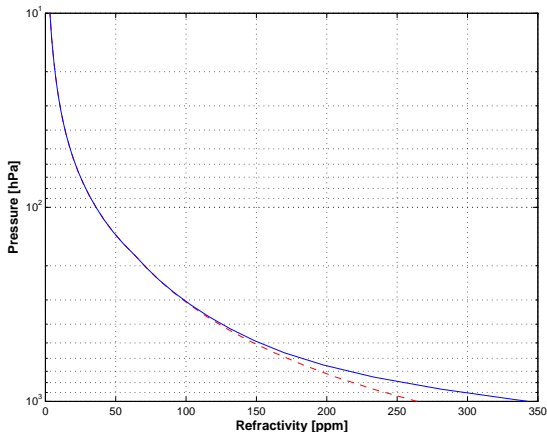
(All figures from "ARTS user guide", Eriksson et al., 2008)

# Atmospheric refraction



Refraction shifts tangent point horizontally and vertically.

# Vertical variation of refractivity $(n - 1) \cdot 10^6$



**Figure:** Vertical variation of refractivity  $(n - 1) \cdot 10^6$ . Calculated for a mid-latitude summer climatology (FASCODE), where the dashed line is for a completely dry atmosphere, and the solid line includes also contribution from water vapour.

# Implementation of refraction in MYSTIC

- 1D spherical mode of MYSTIC to be extended
- Implementation of refraction straightforward by applying Snell's law of refraction at each propagation path step
- Modifications required to compute radiances efficiently: "Local estimate technique in backward mode"